XIII. *Of the Origin and Compound Functions of the Facial Nerve, or Portio dura of the Seventh Nerve;—being the Second Paper in explanation of the difference between the Nerves of the Encephalon, as contrasted with the regular Series of Spinal Nerves.* By Sir CHARLES BELL, *K. H., F. R. SS. L. & Ed., M. D. H. Gott., &c.*

(Read 9th April 1838.)

IN following out the principle formerly laid down—that the study of the organization and functions of the part to which the nerve is distributed, will explain the peculiarities of its origin and connections—I have in this paper entered on a subject of great extent and difficulty.

As the *Facial Nerve* is one of a distinct class, it will be necessary to shew in what that class is peculiar—that it essentially belongs to the act of breathing —that the act of respiration being, in its ordinary condition, independent of the will, there are nerves appropriated to that function. At the same time, it must be shewn, as the apparatus of breathing is made subservient to other purposes in the economy, by what relations it is brought under the influence of the will.

The excited act of breathing extends to the features of the face; and the face, so influenced, is especially the seat of expression. The same parts are the instruments of speech. Hence, it appears, that the nerve which animates the features must have a compound root. It will be my object to shew that the facial nerve has an origin corresponding with its complex operations.

It has been affirmed that I have given up the term Respiratory Nerves. This betrays an ignorance of the whole subject. But as it may have arisen from my imperfect description, I beg the Society to permit me to illustrate this subject, as the necessary foundation of what I have to offer on the nerve of the face. In an inquiry of this kind, the observation of natural phenomena is more agreeable, and more conclusive, than experiments on living animals. With this object, let us notice the actions of the frame at a time when sense and volition are withdrawn.

It is sometimes the severe duty of the physician to watch the act of dying, and to mark its successive stages. A man is not dying, whilst yet the respiration is unembarrassed. But whether he die from violence and loss of blood, or by gradual exhaustion and lingering disease, the act may be said to commence with an excited state of the respiratory organs.

When the vision is clouded, and the eyes want speculation or direction, and

the hand is insensible to the pressure of affection, then the chest rises high at each inspiration, and the muscles of inspiration are prominent in action.

When, through increasing insensibility, the limbs lie relaxed and powerless, the muscles of the shoulders, neck, throat, and nostrils, are visibly excited, and at each inspiration (although we cannot say there is effort, that being an influence of the mind), yet each fibre of the class of respiratory muscles is like a cord in violent tension.

When the decay of life reaches the respiratory system, it first affects the lesser muscles which expand the air-tubes, the muscles of the *glottis* and *velum palati* lose their tone, and these parts becoming relaxed, vibrate in the inspiration of the breath, and cause stertor.

At length the regularity of the respiration is disturbed—there is an interval between the inspiration—the interval is prolonged and irregular, and the action returns with sudden violence, every muscle starts convulsively into action, but with no voluntary effort or struggle. The longer the interval of rest, the more sudden and startling is the return of action, and when we deem all at rest, once more the breath is drawn. At last the action ceases in the chest, whilst yet the throat and cheeks are pulled with a regular succession of actions, and the last fibre which answers to the presence of life, is the *Risorius Santorini* and muscles of the nostril. Two or three times the *Risorius* is drawn with spasmodic twitchings, and then all is still. It is the ultima moriens.

We can hardly miss noticing the resemblance here to natural sleep, the absence of all sense and voluntary motion, and the continuance of the respiration by a property of action which knows neither lassitude nor debility.

In a Society which does not reject the cultivation of literature with science, I may be permitted to quote the beautiful description of HALLER: "Nocte redeunte sensim torpor percipitur in musculis longis, ineptitudo ad cogitationes severiores, amor quietis in animo et corpore. Tunc peculiariter vires corpus erectum tenentes laborant, et oculi nolentes clauduntur, et maxilla inferior pendet, et oscitationis necessitas ingruit, et caput antrorsum nutat, et objectorum externorum actiones minus nos adficiunt, et denique turbantur ideæ," &c.

But, whilst the body, as far as it is subject to the mind, or subject to change through the will, or through passion, is thus at rest, a class of muscles of great extent, seated remote from each other, are combined in simultaneous action. No weariness or exhaustion reaches them. They are most perfect, most regular in action, whilst all besides are at rest.

Thus, we may contemplate the body under two conditions: *First*, Where all is animated, sensitive, and expressive: *Secondly*, Where the body has the semblance of death, and the active powers are at rest. It is natural to seek in the anatomy, and especially in the nervous system, for some correspondence in the structure: nor shall we have far to seek.

Having distinguished that symmetrical system of nerves, the functions of which are sensation and volition, we find nerves which at first appear superfluous. But these superadded nerves, although they produce, when entangled with the others, the appearance of extreme intricacy, are, when taken separately, regular also. For we trace all to a centre, and that centre giving them an origin and a source of power different from the other nerves.

When we see to what order of parts these nerves are distributed, it is impossible to refuse to them the term of Respiratory Nerves. The distinction of animal functions from vital and natural, has always been noticed, and the distinction explained on the supposition of distinct nerves ministering to each; which suggestion was resigned, because anatomists would not agree to any such distinction of nerves. Nevertheless the reasoning was just, and the objection of the anatomists unfounded.

Comparative anatomy affords us the most pleasing view of this respiratory system. From the lowest link of the chain of beings to the highest, there is a progressive series of nerves, increasing in complexity. It is natural to inquire, On what does this complexity depend? In the lower link of the chain of animals, we see the essential operation of decarbonization performed by the contact of air with the fluids circulating over all the frame. We see the same object attained by a sac or cavity, which admits the air, and which sac alternately opens and closes again in other creatures; such cavities communicate with the atmosphere through prolonged and intricate tubes. Witnessing all this, we also perceive the necessity of new nerves of connection. When we further see a new power or faculty bestowed by means of the air which plays through these tubes—voice issuing by their vibration; when we observe that the air drawn through the tubes is diverted into another channel, and made subservient to smelling; when, still ascending to the highest link of the scale, we find the faculty of speech bestowed through the same means,—it would be strange, indeed, if anatomy did not in the same ascending scale disclose an increasing number of nerves.

Again, in the mouth and in the throat are two passages. How shall the one only admit air, and the other food? How shall breathing, deglutition, and speech, coughing, vomiting, be performed, each action differing from another, in the arrangement of some fifty muscles of these tubes? How are these actions ordered, but by a minute and seemingly intricate supply of nerves?

In all animals, man included, the same symmetrical system of nerves, unvarying in any essential circumstance, is devoted to sensibility and locomotion. But the other system, that which is superadded, varies in a remarkable manner; comparatively simple in the animals which merely breathe, complex when the organs of breathing become instruments under the will, they are at once essential to life, and in their higher office minister to the qualities of mind. It would be a strange anomaly, if, with these new faculties, sympathies, and relations, there

were not also an increasing complication of nerves. This intricacy, this fine dependence of the functions, render experiments delusive and unsatisfactory. For we may divide a nerve, one which appears to our conception essential, and no consequent results! We cut a nerve going to the tongue or the throat, and the animal breathes, barks, and swallows. It would be dangerous therefore to conclude that the nerve were superfluous. It is only by an enlarged view of the anatomy that we shall be brought to just conclusions.

From this system I have to select one nerve, and shew how through it, two distinct offices—vital respiratory actions, and voluntary actions—are combined in the face.

The base of the brain being carefully taken out, without tearing the roots of the nerves, and the whole being for a twelvemonth preserved in spirits, we may commence the dissection. The *medulla oblongata* and *pons varolii* being cleared of their membranes, and the places of the *sixth* and ninth nerves noted, we clear and arrange the filaments of the eighth pair, and the *portio dura* of the seventh.

We see the *facialis* or *portio dura* of the seventh nerve coming out from the depth between the convexity of the *pons* or *nodus cerebri*, the *corpus olivare*, and the root of the auditory nerve. This nerve we have now to trace inwards, and in the substance of the *pons* or *nodus*.

We shall not find this nerve arising in separate filaments, but in a flat layer of nervous matter, which fan-like spreads into the nodus.

To understand the full consequence of this form of the root, we must make a section of the *nodus* or *pons*, to shew the manner in which the motor tract expands within it. Previous to this let the sixth nerve, and *portio dura* of the seventh, be thrown forwards, and the glosso-pharyngeal and nervus vagus laid aside. If we now dissect close round the corpus olivare, the motor column will be found bending round that body; and now, by following the root of the *portio dura* inwards, its origin from the column of voluntary motion will be apparent. One portion diverging towards the sixth nerve, the other towards the glosso-pharyngeal nerve. See Fig. 3, (6, 7, and 8,) also Fig. 4, in which the relations of the nerves are made more distinct. By proceeding differently, we obtain a better view of the common origin of the eighth pair and *portio dura*. Cut across the *processus ad cerebellum*, and open up the fourth ventricle. Trace the roots of the eighth pair inwards. You find the column from which they arise in the form of a *tractus* ascending to the *corpora quadrigemina*, the *valvula cerebri* forming the commissure of the two respiratory tracts. From this tract the *portio dura*, now viewed from behind, will be seen to take an origin.

We may now have a view of the relation of the respiratory nerves to the sensitive column of the *medulla oblongata*, either by tracing up the sensitive column from the spinal marrow, or by tracing down the sensitive root of the fifth nerve.

We shall now find that the eighth pair, that is to say, the *nervus vagus* and *glosso-pharyngeus*, is situated so as to draw roots from the sensitive column.

By such a mode of dissection, it will be found that the facialis or *portio dura* of the seventh nerve has direct connection with the motor and respiratory columns, and hardly less directly is related to the fourth and sixth nerves.

The facial nerve, thus arising, allies itself with the auditory nerve, and passes into the temporal bone. In its passage through that bone, it exchanges fibres with the branches of the fifth nerve, and after some intricacies, escapes by the *stylo-mastoid foramen*, to expand upon the cheek, and finally to reach every part on the side of the head, with the exception of the muscles of the jaws. Although its connection on the side of the neck countenances the view I am about to give of this nerve, yet we must draw our inferences chiefly from the origin and functions of the nerve.

Of the Function of the Facial Nerve, or Portio Dura.

In the facial nerve we have an organ of most complex operation. It combines the passages with the great internal organ of respiration. It animates the lips and cheeks in combination with the organs, so as to give both speech and expression. It is the source of all the sympathetic actions which illuminate the features in unison with the condition of the mind. It has some remarkable effects on the eyes, which subject we shall reserve to be taken apart from the present inquiry.

That the facial nerve is the respiratory nerve, I early shewed, by dividing it in brutes; when, although sensibility remained, all action in the face was cut off, excepting the motion of eating. Many occurrences in the practice of my profession have exhibited the same results from the same cause in man.

Though one of the most celebrated philosophers of our day, Dr YOUNG, asked rather querulously, "What had the face to do with respiration?" yet must it be obvious (unless, indeed, the mind be exclusively engaged in observing the chemical phenomena of the economy), that the tubes which give passage to the air, being soft and pliant, and subject to the pressure of the atmosphere, must be dilated, and their sides held apart by muscular action. How also are they to admit of breathing, and more especially, how is the expansion of the tubes to be adapted to the excited condition of breathing? I have already alluded to the stertor consequent on the relaxation of the tubes in apoplexy. And when this nerve is deprived of power, we find the relaxed lips playing in the act of breathing like the flapping of a sail.

It will not therefore be again asked, why a branch of that system of nerves which animates the organs of respiration extends to the lips and nostrils, as other branches tend to the *velum palati*, the throat and larynx.

Considering the nerve in this, perhaps its most important function, that is operating upon the tubes or passages for the breath, during sleep and insensibility, we have next to contemplate it, as combining the effort of the will in unison with that of respiration. It is in this combined exercise that we have to be most grateful for the effect,—the vibrations of the tubes modulated into articulate language,—the performance at once of that function most necessary to existence, and that faculty of speech essential to the developement of the powers of the mind as the *instrument* of thought.

Finally, the facial nerve is the source of expression. If the properties of this nerve through any accident be lost, accidentally cut across, pressed on by a tumour, or engaged in inflammation, the corresponding side of the face remains motionless and blank. The cheeks and lips are blown out like a window-blind. They have neither tension nor action. *Expression*, whether in laughter or in tears, and all the intermediate conditions, continue to influence the other side of the face, but with frightful distortions, pulling upon the side which has lost power.

There are instances recorded, now that the cause is understood, of entire loss of expression on *both* sides of the face. A young woman, in whom the roots of the nerve on both sides were involved in disease, exhibited the most distressing consequences,—for whether she laughed or cried, the features were immoveable. She laughed under a mask, a sad thing to witness, a light heart behind a face in the repose of death.

There is an animation coincident with speech, and a reflection of the mind in the human countenance, *at all times*. We have the full sense of this only from the effects of this nerve being cut, for then the features are completely fallen, more divested of expression than a mask or a bust, for it is not the fixed state of a *statue* which has *meaning*, but something worse than death.

If this condition of total inaction continue, the plumpness of the face is lost, and the skin becomes like a piece of parchment stretched over the bones. It is a remarkable thing to see, in one sense, the life and sensibility of the parts remaining, whilst there is a ruin of all which is a reflection of the mind. The muscles of the jaws, however, remain as powerful and active as before, having their energies excited through the nerves of the other system.

We now perceive the correspondence between the roots of the facial nerve and the offices it has to perform in the face. We recognise its double roots, its relation to two distinct columns in the performance of two distinct functions. We perceive its lively subjection to the will, because of its relation to the motor column, whilst its origin in common with the eighth pair of nerves explains to us how it is that the nostrils and lips move simultaneously with the other parts engaged in the act of respiration; in other words, how the vital actions through

the influence of this nerve are continued during the repose or annihilation of sensation and volition.

It is not possible to account for all the finer operations of the features by the investigations of anatomy. Yet we see that this nerve arises in most peculiar circumstances, that its roots are connected with the *nodus cerebri*, a name well chosen, since in it, without exaggeration, fibres are crossing in every possible direction. We may display these fibres, and we may suppose that each filament has its influence; but it is better to stop short of conjecture, and to rest on the demonstrated fact that this nerve is special, in one sense a double nerve, not, however, like the double nerves of the spine, where action and sensibility are conjoined, but double in as far as two modes of action are effected through it; one independent of mind, the other answering to its slightest emotions.

There is indeed nothing more remarkable than those distinct offices, and that variety in the motion of the features, arranged and controlled through a single nerve not larger than a thread, combining the features in the general act of respiration, giving utterance in speech, and indicating every degree and variety of emotion.

I had at one time been deceived into the belief that laughter, and all the changes of the face indicative of what is pleasurable or ludicrous, were but the result of the degrees of relaxation of the muscles, as it were a defect of action. Such an opinion is untenable when we perceive the consequences of the loss of this nerve, for its defect of influence, so far from giving place to a smile, reduces the features at once to the most painful and melancholy relaxation.

Laughter, and all the changes of the countenance indicative of pleasurable emotion, are neither the effect of relaxation nor of spasm incidentally produced. It is a balanced condition of the features, in which certain muscles are in activity, whilst others are thrown out of action. In the painful emotions, still influencing the features through the same nerve, another classification of muscular actions takes place; some muscles in tension, others incontrollably relaxed, both conditions, and all the intermediate states, are designed as the outward signs of passion; and from which are afforded the highest and the most unceasing gratification, a language which is the charm of life, and the bond amongst men.

But I am somewhat trespassing, and deviating from the proper object of the paper, which was to shew in what the facial nerve or *portio dura* is distinguished from the symmetrical nerves—that it is in a different sense a compound or double nerve, and that its roots correspond so far with its various functions.

In my next paper, I shall endeavour to shew the necessity of combination between the Facial Nerve and those which enter into the orbit.

EXPLANATION OF PLATE XIV.

Fig. 1, A, B, Section of the *Crus cerebri.*

A, Motor column.

B, Sensitive column.

C, The Third Nerve, arising from both columns.

D, E, *Tractus opticus*, passing round the motor column.

Fig. 2, A, Section of right *Crus cerebri.*

B, Distinct fasciculi of the Third Nerve, arising from the muscular column.

C, Similar fasciculi of the nerve arising from the sensitive column.

D, The union of the fasciculi in a dense ganglionic texture.

Fig. 3, Represents the origins of the nerves from the *Pons Varolii* and *Medulla Oblongata.*

5, The Fifth Nerve in its two portions.

6, The Sixth pair; the nerve of the right side unravelled.

P. D. 7, The Portio dura of the Seventh Nerve.

P. M. 7, The Portio mollis.

8, The Glosso-pharyngeal, Nervus vagus, and Spinal Accessory, forming the Eighth pair.

9, The Lingualis.

The foramina, both large and numerous, mark the provision for the entrance of blood-vessels, from which we may deduce the vital importance of the nerves.*

Fig. 4, An enlarged view of the roots of the Sixth, of the Portio dura or Facialis, and of the Glosso-pharyngeal nerve.

A, The Pyramidal body.

B, Corpus olivare.

* Consult the interesting paper by Sir ASTLEY COOPER on the obstruction of the Vertebral Artery.

PLATE XIV.

Trans. Roy. Soc. of Edin. Vol. XIV. p. 236.

Fig. 3.

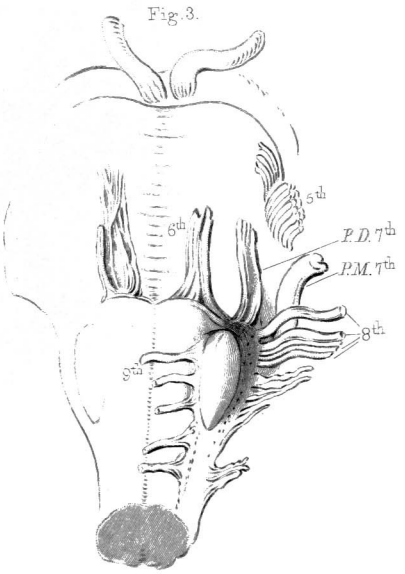


Fig. 2.

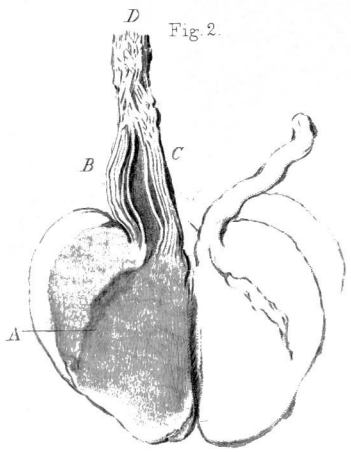


Fig. 4.

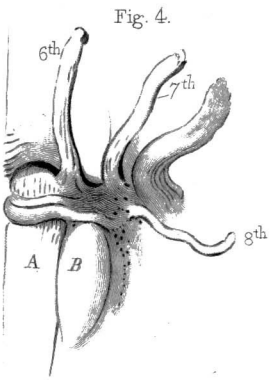
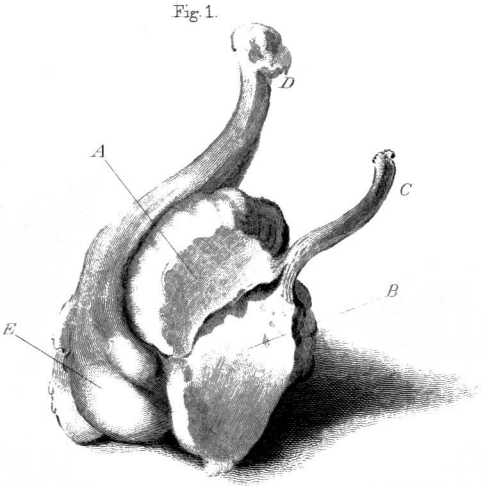


Fig. 1.



Sir C. Bell delt.